that the primitive forms of the Caspian are freshwater animals (*e. g. Dreissena polymorpha*), and then that the emigrants from the glacial sea which reached it are marine animals for the most part inhabiting great depths. Hence, also, we recognize that the Caspian in its fauna presents more affinities with the glacial than with the Black Sea, which, again, has become richer in animals under the influence of the Mediterranean.

The Caspian has not only received species from the glacial sea, but has also furnished it with some—as, for example, a species of sturgeon, which seems to be *Acipenser ruthenus*, and lives in the rivers of Siberia. I regard the Sturgeons as belonging to the ancient Aralo-Caspian basin, and as having emigrated, as has been said, into the glacial sea, and perhaps even to America, where, as is well known, the nearest relatives of the *Scaphirhynchi* of the Aral exist. On the other hand we may presume that the place of origin of the Acipenseridæ was the Indian Ocean, and that they were derived from the Selachia, with which, especially when young, they have many points in common (*e. g.* their teeth).

I shall only add a few remarks. The Oxus of the ancients unquestionably fell formerly into the Caspian Sea. In this sea the abundance of animal species is replaced by an abundance of individuals; and the greater number of the species of Mollusca described by Eichwald as subfossil have been found by me in the living state, and are represented by individuals as large as their fossil relatives. Lastly, the deepest parts of the sea have been found to be most abundantly populated with species of animals quite different from those which inhabit the regions having only a depth of a few fathoms.—*Zeitschr. für wiss. Zool.* vol. xxv. p. 322, 1875; *Bibl. Univ., Bull. Sci.* December 15, 1875, p. 427.

On Fossil Remains of Reptilia and Fishes from Illinois.

By E. D. Cope.

John Collett, the accomplished assistant of Prof. Cox of the Geological Survey of Indiana, recently submitted to my examination a number of vertebrate remains from some point in Illinois. The specimens were taken from a blackish shale, and consist of separate vertebræ and other elements of the skeleton, often in a fragmentary condition. Although the absence of information as to the mutual relations of the pieces renders the identification difficult, yet the interest attaching to them, in consequence of their peculiar forms and the locality of their discovery, renders it important to determine their zoological position. Mr. Collett informs me that all the specimens were found near together, and at the same horizon, by Dr. Winslow. Much credit is due to Dr. Winslow for the painstaking labour bestowed in procuring and cleaning the specimens, and for his liberality in presenting them to the geological collection.

A remarkable peculiarity of all the vertebræ of the series is the longitudinal axial perforation of the centrum. They present the character observed in *Archegosaurus* and other stegocephalous Batra-

chia, but which also exists, according to Günther, in the living Rhynchocephalous lizard the *Sphenodon* of New Zealand. The bones of the limbs and scapular arches are so decidedly reptilian, and so unlike those of any Batrachia with which we are yet acquainted, that I am disposed to refer them to the former class. And as there are several points in which the fossils resemble the order Rhynchocephalia, I refer them provisionally to that neighbourhood. They constitute the first definite indication of the existence of animals of that type in the western hemisphere.

Associated with these saurians were found teeth of two species of fishes, which are important in evidence of the position of the beds in which they occur. One of these is a new species of *Ceratodus*, Agass., and the other a *Diplodus*. The former genus is characteristic of the Triassic period in Europe, one species having been found in the Oolite. It still lives in North Australia. In both these respects the Rhynchocephalian lizards present a remarkable coincidence. They also belong to the horizon of the Trias in Europe; and the only living species is found in New Zealand. Thus it would seem that a fragment of this fauna, so ancient in the northern hemisphere and so remarkably preserved in the southern, has been brought to light in Illinois. It must be added, in reference to the geological age of the fossils, that the genus *Diplodus*, Ag., has not yet been discovered above the Carboniferous, and that one genus of the Rhynchocephalia belongs to the Permian in Germany. We therefore await further material before venturing to decide whether they belong to Triassic or Permian time.

Cricotus heteroclitus, Cope.

Generic characters.—This genus is indicated primarily by caudal vertebræ; other parts of the skeleton found with it probably belong to the same animal; so I describe them in this connexion, awaiting further discoveries to confirm or disprove such reference. The pieces include parts of two femora, of tibia ?, ulna ?, metapodial and phalangeal bones, ribs, and other pieces.

The caudal vertebra best preserved is stout, discoidal in form, and deeper than wide. It resembles in form that of an herbivorous Dinosaurian, but differs otherwise. The articular faces are deeply concave, the posterior most strongly so; and the middle is occupied by a large foramen, whose diameter is about equal to that of the centrum on each side of it. The lateral borders of the posterior articular face are expanded backwards, and articulate with a bevel of the corresponding edge of the anterior articular extremity. In this way the vertebra combines the mechanical relations of the biconcave with the opisthocœlian structures. The neural arches are narrow and directed backwards; their bases are firmly coossified with the centrum; no zygapophyses appear on the portion of the neurapophyses preserved; and it is probable that they were weak if existing. On the inferior surface of the centrum two shallow pits occupy considerable space, and indicate the existence of large, free chevron bones. No transverse processes. In one vertebra the floor

of the neural arch is deeply excavated; in the other it is plane and marked with a median groove.

Of the remaining bones it may be observed that the articular faces were evidently capped by cartilage, and do not present the smooth condyloid character common to so many reptiles. They are, indeed, not so smooth as the dense layer of the shafts and surrounding portions, which rises in a fine bounding ridge round the surface formerly capped by the cartilage. The articular end of a bone may be the proximal end of the femur. The section of the shaft resembles that of a T-rail—the lesser expansion representing the base of the trochanter, and the greater that of the head. Seen proximally, the head is transverse and truncate, as in the great trochanter of many mammals, while the trochanter is smaller, oval in section, and oblique to the head. There are two articular facets on the head: the larger extends across the inner side; the smaller is subround, and is directed inwards or towards the trochanter; the two are separated by the ridge of a right angle.

A supposed distal end of a metapodial bone displays a shallow trochlear face of not much antero-posterior diameter. A phalange is of remarkable form, resembling that of an herbivorous Dinosaur in its short wide proportions. The articular faces are slightly trochlear in their character; and the inferior is directed inferiorly at an angle of 45° to the axis of the shaft. The form indicates a digitigrade terrestrial form. The proximal end of a rib exhibits the section of the shaft and the head. The latter has a broad, tubercular articular surface, and a smaller capitular surface on the narrow produced head. The section of the shaft is lenticular.

This genus appears to combine some Dinosaurian characteristics with those in which it resembles the Rhynchocephalia. This association of diverse features is confirmed by those observed in the genus *Clepsydrops*, Cope, described below.

Specific characters.—The surface of the sides of the centrum is marked with a few coarse shallow longitudinal grooves, which run into shallow reticulations of weak raised lines. The neurapophysis is sharp-edged in front, and with some ridges externally at the base.

The edge of the posterior articular face is excavated opposite to the chevron-facets. The latter are large, separated by a flat surface, and bordered externally by a raised edge from the polished dense layer of the lateral face.

	metre.
Diameter of centrum, vertical	·021
,, ,, transverse	·019
,, ,, longitudinal	·011
Width of neural canal	·006
,, of neurapophysis	·004

The superficial layer of the other bones is smooth or striate and rugose near articular extremities. The distal end of the head is oblique, and the side below it concave for a short distance. The very short shaft of the phalange is concave, almost emarginate on one margin. The borders of the tubercular head of the rib are thin and broadly flared outwards at the sides.

	metre.
Transverse proximal diameter of femur	·024
Antero-posterior diameter of head of femur	·018
Transverse diameter of shaft of femur	·015
Vertical diameter of shaft of rib	·008
„ „ rib at tubercle	·016
„ „ rib at head	·006
Transverse diameter of tubercle of rib	·008
Proximal width of phalange	·014
Proximal depth of phalange	·007
Length of same phalange	·010

The remains indicate an animal more robust than any existing lizard, but probably not so long as some of the larger *Varani*.

Clepsydrops Collettii, Cope.

Generic characters.—This genus reposes on a series of vertebræ, which includes cervicals, dorsals, and caudals; associated with these are proximal ends of ribs, a coracoid bone, and some phalanges, which are provisionally referred to the same. They bear the same relation of size to the vertebræ that the corresponding bones do to the vertebræ of the *Cricotus heteroclitus*, and have a proportionately more slender form, like the vertebræ in *Clepsydrops*. They belong in any case to an allied form.

The vertebræ on which the genus reposes are more elongate than the corresponding ones of *Cricotus*. They are deeply biconcave, the articular cavities being funnel-shaped and continuous, thus perforating the entire length of the centrum. In a dorsal vertebra the cavities communicate by a very small orifice, while in the posterior the median contraction of the canal is less marked. The posterior cavity is more gradually contracted than the anterior; in the latter the excavation is, in most of the vertebræ, but slight (except beneath the floor of the neural arch), until it falls rather abruptly into the axial perforation. In an anterior (?) dorsal it is as widely excavated at the border as the posterior funnel. Another peculiarity is the absence of processes of the centrum; and a small capitular articulation is seen sessile on the border of the cup of two of the dorsals.

The axis has a singular form, owing to the tubular perforation which continues the posterior excavation to the anterior face of the centrum. There are three articular faces—a larger subround inferior, and two smaller superior, which border the neural canal in front and below, and are separated from each other and the inferior face by the perforation in question. The anterior face slopes obliquely backwards and downwards, and is convex in transverse section. There is no facet for the free hypapophysis of the odontoid; but it appears that the inferior articular face was applied exclusively to the centrum of the atlas, as in *Sphenodon*. But the axis differs from that of the latter genus in the absence of a coossified odontoid process. Either that element is altogether wanting, or it consists of two pieces, interrupted in the middle by the notochordal foramen, and in correspondence with the superior articular facets. There is no true hypapophysis of the axis; and the only indication of lateral

processes is a small articular facet on each side on the lower part of the rim of the posterior funnel. These may have been related to rudimental cervical ribs. The neural arch is broken off.

The dorsal vertebræ have their sides somewhat contracted: in one specimen the inferior face is rounded; in another (which I suppose to belong to a different part of the column) it is longitudinally acute. In this and another dorsal, where the parts are exposed, the floor of the neural canal is interrupted by a deep fissure, which has a triangular shape with the apex downward, when seen in profile. This is due to the fact that the opposite halves of the centrum are united by the circumferences of the articular cups, which have in profile an ⋋ shape. The diapophysis does not project far beyond the base of the neural arch, and is compressed.

The caudals are elongate, and resemble, in the forms of the centrum and neural arch, those of *Lælaps*. The neural spines are not preserved, but, if present, were directed well backwards, bearing the posterior zygapophyses, since the arch stands only on the anterior three fifths of the centrum. Chevron-facets are not distinct; but two emarginations on the rim of the posterior face of one of the vertebræ indicates their existence; in other centra even these notches are wanting. The tail was evidently tapering. There is no indication of the transverse fissures seen in *Sphenodon* and many Lacertilia, nor are there any diapophyses on the caudal vertebræ preserved.

Two vertebræ accompanying the above are similar in general characters, and appear to belong to the sacrum. If truly such, they indicate a structure different from that seen in Lacertilia and Crocodilia, and present some resemblance, perhaps only superficial, to the Dinosauria. The centrum is much compressed; and the articular extremities present a wide plane border below the notochordal perforation. The corresponding part of the centrum presents no indication of diapophyses. Neural arch lost.

Some heads of ribs of appropriate size are compressed, and exhibit a small tuberosity, which is perhaps a rudimental capitulum. They are much more lizard-like than those of *Cricotus*.

The phalanges are of more slender form than those of *Cricotus*, and more like those of lizards, although less slender than usual among that order. The shafts are sometimes little, sometimes much depressed. The distal condyle of one of the latter is not emarginate. An ungual phalange is subconic, flat below, and with a shallow groove above one of its lateral borders.

A coracoid bone supports the greater part of the glenoid facet, and exhibits also a facet for the scapula; these are flat, and not excavated. Its form is that of an irregular right-angled triangle, the base anterior and the outer angle truncated by the glenoid facets; its inner margin is thickened and truncated as though it had been articulated with a mesosternal or opposite coracoid bone. This may not be a correct interpretation of its appearance; for if so, the arrangement would differ equally from that of *Sphenodon*, Lacertilia, and Salamanders, and resemble that of the Sauropterygia. And it is not to be denied that there are other points of resemblance to the coracoid of that order. There is an anterior marginal facet as though

for a clavicle, and a short oblique postero-internal one, as though adapted for a small sternum. There is a shallow notch on the inner border anteriorly, corresponding to one of those of the Lacertilia.

This genus is more typically Rhynchocephalian than *Cricotus*.

Specific characters.—There is a shallow fossa in the entering angle between the superior and inferior articular facets of the front of the axis; and the centrum of the same is obtusely keeled below. The border of the anterior articular face of the dorsal vertebra with keeled centrum is undulate. The obtuse inferior face of another dorsal is rugulose, and the edge of the articular face is not undulate. The inferior faces of two caudals are marked with two fine parallel grooves, while in another caudal and the sacrals (?) the same is smooth. There are some longitudinal ridges on the upperside of the larger caudal. The coracoid is concave on its inferior side, convex on its superior; the inner and anterior borders are thickened by flaring of the edges. Surface smooth. The posterior edge is thin, and is notched just behind the glenoid facet. The proximal facets of the phalanges are shallow, simple, and more or less transverse.

	metre.
Centrum of axis, length	·006
,, ,, width at middle behind	·008
,, ,, depth (oblique)	·010
Centrum of sharp-keeled dorsal, length	·014
,, ,, ,, depth behind	·012
,, ,, ,, width behind	·012
Centrum of rounded dorsal, length	·012
,, ,, depth behind	·011
,, ,, width behind	·0105
Width of neural canal of rounded dorsal	·004
Centrum of larger caudal, length	·014
,, ,, width	·0085
,, ,, depth	·008
Length of base of neural arch of larger caudal	·008
Smaller caudal, length	·0105
,, depth of centrum	·007
,, width of centrum	·007
Width of rib-head	·010
Coracoid, length	·024
,, width	·019
Diameter of glenoid facet (transverse)	·009
Diameter of inner border (vertical)	·006
A phalange, length	·010
,, depth proximally	·004
,, width proximally	·007

This species was of smaller size than the *Cricotus heteroclitus*. It is dedicated to John Collett, of Newport, Indiana, of the State Geological Survey.

Ceratodus Vinslovii, Cope.

Represented by a tooth in good preservation, lacking only a fragment of one end and a portion of the inner margin of the base. The crown of the tooth is in general outline an oval, wider at one

end than the other; the inner border gently convex and entire; the outer border is marked by six shallow notches, which are separated by as many sharp compressed projections. The emarginations and denticles are the termini of corresponding grooves and ridges, which radiate from a smooth space along the inner margin of the crown. From this plane the grooves gradually deepen to the margin; the separating ridges are acute, and without irregularity or serration. The base or root of the tooth is quite wide; externally it extends beyond the border of the crown at the notches, and has projections corresponding to the denticles, from which it is separated by a horizontal notch. On the inner side the base extends like a shelf beyond the posterior half of the crown, and is produced backwards beyond its posterior border. The inferior plane is concave in transverse section; the crown is plane in all directions.

	metre.
Length of crown preserved	·021
Width of crown	·013
Length of root preserved	·022
Depth of tooth internally	·005
„ externally	·003

This *Ceratodus* resembles the species described by Agassiz under the names of *C. parvus* and *C. serratus* from the English Trias, but differs from them in the shortness of the tooth-like processes. In none of the described species do I find such a development of the basis on the inner side.

This species is of interest as introducing the genus to North America. It is dedicated to Dr. Winslow, to whom we are indebted for its discovery.—*Proc. Acad. Nat. Sci. Philadelphia*, September 28, 1875.

Formation of Nitrites by Bacteria.

The presence of nitrites in spring-waters, which has usually been ascribed to the oxidation of ammonia therein, is now stated by Meusel to be produced by the reduction of nitrates by the agency of *Bacteria*. In proof of this he shows:—that such water which contained *Bacteria* and nitrates, but neither ammonia nor nitrites, gave after standing four days the reactions of nitrous acid; that antiseptics, such as salicylic acid, phenol, benzoic acid, alum, and much salt even, prevent or hinder the production of nitrites; that aqueduct-water containing pure nitrates, which alone does not show the production of nitrites even in presence of *Bacteria*, has this change effected upon the addition of glucose, gum, dextrin, cellulose, starch, &c., in the course of from two to fourteen days; that freshly distilled water, boiled with glucose and nitre, shows no nitrites even after standing for weeks, because *Bacteria* are absent; and that putrefying albuminates reduce nitrates to nitrites. The decomposition of cellulose by *Bacteria* in presence of nitrates proves that nitre is not only direct food for plants, but that it also performs by its oxygen an important function in the soil. The author believes that these facts have important bearings in agriculture and in medicine. —*Silliman's American Journal*, January 1876.